Track Preference: Take a Chance

Presentation Title: When Failure Means Success: Accepting Risk in Aerospace Development

Synopsis

Failure is an option during testing, providing valuable lessons that actually lead to mission success. This presentation will use flight demonstration testing failures as the basis for discussing when to accept higher risk levels in non-human-rated vehicles, such as the upcoming Ares I-X mission.

Abstract:

Over the last three decades, NASA has been diligent in qualifying systems for human space flight. As the Agency transitions from operating the Space Shuttle, its employees must learn to accept higher risk levels to generate the data needed to certify its next human space flight system. The Marshall Center's Engineering workforce is developing the Ares I crew launch vehicle and designing the Ares V cargo launch vehicle for safety, reliability, and cost-effective operations. This presentation will provide a risk retrospective, using first-hand examples from the Delta Clipper-Experimental Advanced (DC-XA) and the X-33 single-stage-to-orbit flight demonstrators, while looking ahead to the upcoming Ares I-X uncrewed test flight. The DC-XA was successfully flown twice in 26 hours, setting a new turnaround-time record. Later, one of its 3 landing gears did not deploy, it tipped over, and was destroyed. During structural testing, the X-33's advanced composite tanks were unable to withstand the forces to which it was subjected and the project was later cancelled. These are examples of successful failures, as the data generated are captured in databases used by vehicle designers today. More recently, the Ares I-X flight readiness review process was streamlined in keeping with the mission's objectives, since human lives are not at stake, which reflects the beginning of a cultural change. Failures are acceptable during testing, as they provide the lessons that actually lead to mission success. These and other examples will stimulate the discussion of when to accept risk in aerospace projects.

Contact Information

Name: Daniel L. Dumbacher

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Biography:

Daniel (Dan) L. Dumbacher is Director of the Marshall Space Flight Center's Engineering Directorate. where he leads a workforce of about 1,400 civil servants and 1,200 contractors. The Directorate performs sustaining engineering for Space Shuttle propulsion elements, manages scientific operations on the International Space Station, and is developing the Ares I crew launch vehicle and designing the Ares V cargo launch vehicle, in addition to establishing the Integrated Lunar Network and supporting a host of scientific missions. Prior to this position, Mr. Dumbacher was Deputy Director of the Ares Projects Office and was Deputy Director for Product Assurance in the Safety and Mission Assurance Office during the Shuttle's return-to-flight activities. Before his appointment as Deputy Manager of the Space Launch Initiative, he led the DC-XA and X-33 flight demonstrator projects. He served as Assistant Manager of the Space Shuttle Main Engine Project and later managed that project from NASA Headquarters. He was Chief Engineer for the Space Shuttle Main Engine Alternate Turbopump Project and worked for a time in private industry with Teledyne Brown Engineering. He began his NASA career in 1979 as a liquid propulsion engineer, working closely with Saturn-era engineers to develop the Shuttle's propulsion system. Mr. Dumbacher received his bachelor's degree in mechanical engineering from Purdue University and a Master's in Administrative Science from the University of Alabama in Huntsville. He has authored numerous papers on liquid propulsion and systems engineering, and recently presented the keynote speech at Purdue's Global Engineering Colloquium Mr. Dumbacher was named Purdue's Outstanding Mechanical Engineer of the Year in 2003 and received the Presidential Rank Award for Meritorious Executives in 2007.

Name: Christopher E. Singer

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Biography:

Christopher (Chris) E. Singer is Deputy Director of the Engineering Directorate at the Marshall Space Flight Center, where he leads a workforce dedicated to designing, testing, evaluating, and operating hardware and software associated with space transportation, spacecraft systems, science instruments, and payloads being developed and managed by Marshall. Before this assignment he served as Chief Engineer, Deputy Director, and Acting Director of the Space Transportation Directorate. He was the Technical Assistant to the Space Shuttle Main Engine Project Manager and later took an assignment at NASA Headquarters as Senior Manager of the Space Shuttle Main Engine and External Tank in the Space Shuttle Support Office. He began his NASA career in 1983 as a rocket engine specialist in the Structures and Propulsion Laboratory. Mr. Singer holds a bachelor's degree in mechanical engineering from Christian Brothers University in Memphis, TN. The author of numerous papers on space transportation systems and operations, Mr. Singer delivered the keynote address on "Success Through Failure" at Christian Brothers University's 50th anniversary. He has received numerous awards, including a Silver Snoopy from the Astronaut Corps and the Presidential Rank Award for Meritorious Executives in 2006.

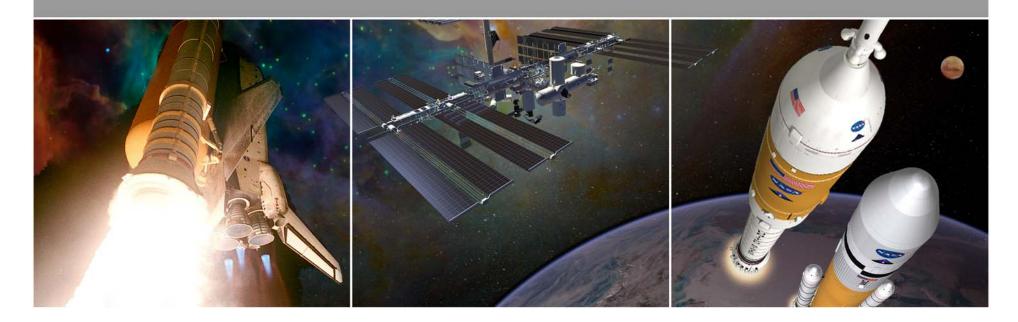


When Failure Means Success: Accepting Risk in Aerospace Projects

NASA Project Management Challenge 2009

Daniel L. Dumbacher, Director Christopher E. Singer, Deputy Director





Engineering Directorate
Marshall Space Flight Center

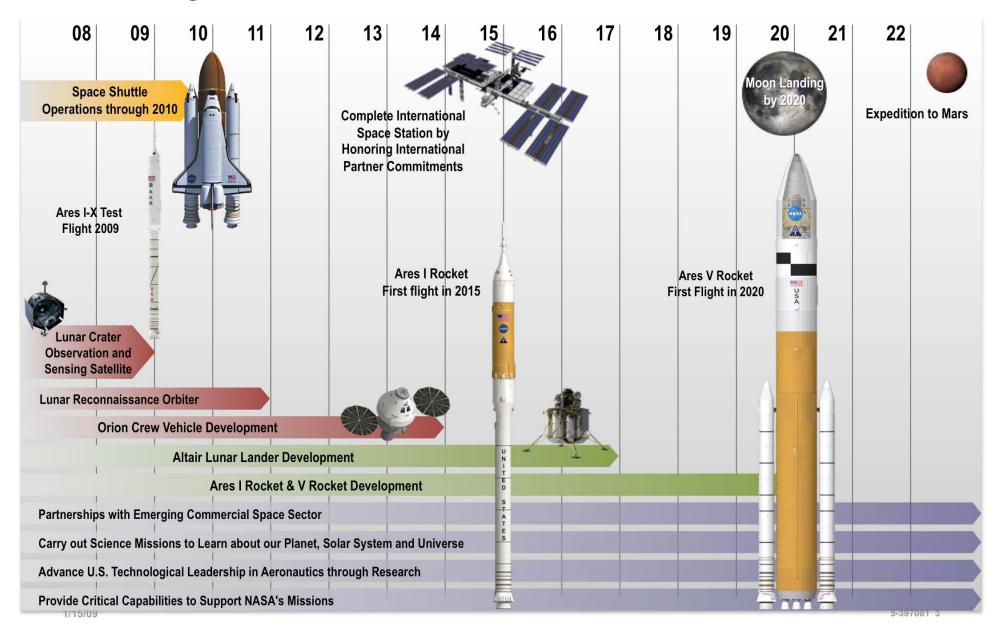
Agenda



- Evolving from Saturn, to Shuttle, to Ares
- Expanding Frontiers for 50 Years and Counting
- Harnessing Risk Management Techniques and Tools
- Applying Human Space Flight Testing Philosophy
- Learning Lessons from the 1990s: Delta-Clipper Experimental Advanced Demonstrator
- Learning Lessons from the 1990s: X-33 Single-Stage-to-Orbit Flight Demonstrator
- Transitioning from Shuttle to Ares: Hard-Won Lessons
- Reducing Shuttle Risk: HD Cameras Visualize ET Foam Loss
- Reducing Shuttle Risk: Main Engine Cutoff (ECO) Sensor
- Reducing Technical Risk for Ares I Crew and Ares V Cargo Launch Vehicles
- Systems Engineering Throughout the Project Lifecycle
- Testing for Knowledge versus Testing for Success
- Ares I Project Milestones
- Ares I-X Development Flight Test: Breaking the Systems Engineering Model
- Generating and Analyzing Data to Reduce Risk: Main Propulsion Test and Integrated Ground Vibration Test
- Adopting Other Risk Reduction Methods: Project Lifecycle Management
- Engineering Knowledge Management System
- Conclusion: Reducing the Risk Inherent in the Human Exploration of Space

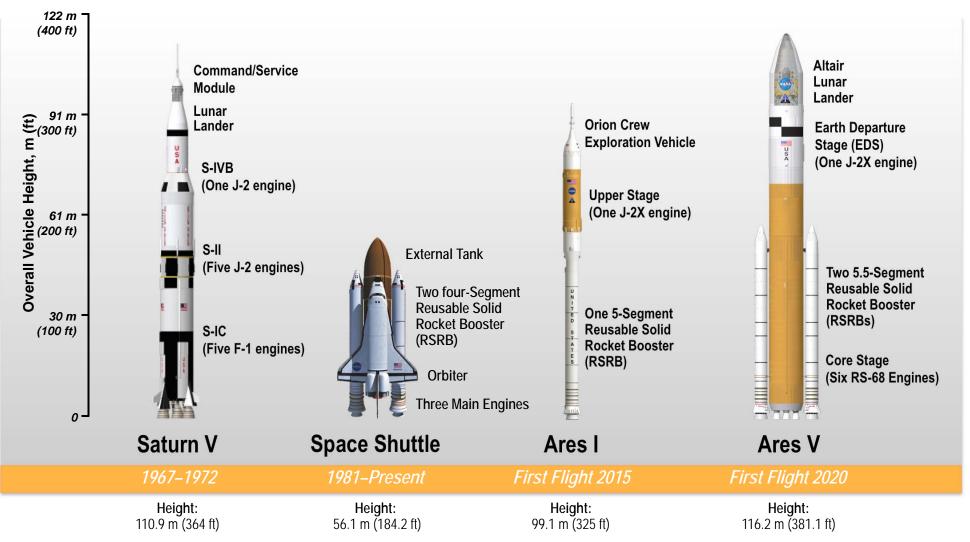
NASA

Evolving from Saturn, to Shuttle, to Ares



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Expanding Frontiers for 50 Years and Counting



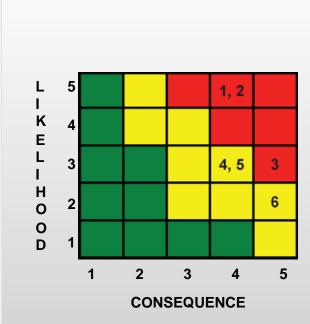
Payload Capability: 44.9 metric tons (99,000 lbs) to TLI 118.8 metric tons (262,000 lbs) to LEO Payload Capability: 25.0 mT (55,000 lbs) to LEO

Payload Capability: 25.5 mT (56,200 lbs) to LEO

Payload Capability: 187.7 mT (413,800 lbs) to LEO 71.1 mT (156,700 lbs) to TLI with Ares I

Harnessing Risk Management Techniques and Tools





R a n k	T r e n d	Title	Owning Team	LIKE	Consequence			
					S A F E	P E R F	S C H E D	C O S T
1	->	■ 2075 - First Stage Thrust Oscillations	VI	5	0	4	0	0
2	•	♦ 1716 - Manufacturing and Assembly Common Bulkhead Risk	US	5	3	0	4	4
3	->	♦ 3345 - Contact with Mobile Launcher Platform (MLP) During Liftoff	VI	3	5	4	5	5
4	->	♦ 1118 - Ability for Ares I to Meet Performance Requirements	VI	3	0	4	0	3
5	->	♦ 1154 - Launch Vehicle Operability	VI	3	0	4	0	3
6	->	♦ 2300 - Ares I First Stage- Upper Stage Staging Recontact	VI	2	5	5	5	5



Likelihood Plus Consequence Equals Risk Level

Applying Human Space Flight Testing Philosophy





Considering the Crew Drives Levels of Analyses

Learning Lessons from the 1990s: Delta-Clipper Experimental Advanced Demonstrator



Defining Hardware Limits through
Technology Development Flight Testing

Learning Lessons from the 1990s: X-33 Single-Stage-to-Orbit Flight Demonstrator





Pushing the Limits of Technology

Transitioning from Shuttle to Ares: Hard-Won Lessons





"The great liability of the engineer compared to men of other professions is that his works are out in the open where all can see them. His acts, step by step, are in hard substance. He cannot bury his mistakes in the grave like the doctors. He cannot argue them into thin air or blame the judge like the lawyers. He cannot, like the architects, cover his failures with trees and vines. He cannot, like the politicians, screen his short-comings by blaming his opponents and hope the people will forget. The engineer simply cannot deny he did it. If his works do not work, he is damned."

— Herbert Hoover

U.S. Mining Engineer & Politician (1874 – 1964)

Applying 30 Years of Lessons Lived

Reducing Shuttle Risk: HD Cameras Visualize ET Foam Loss

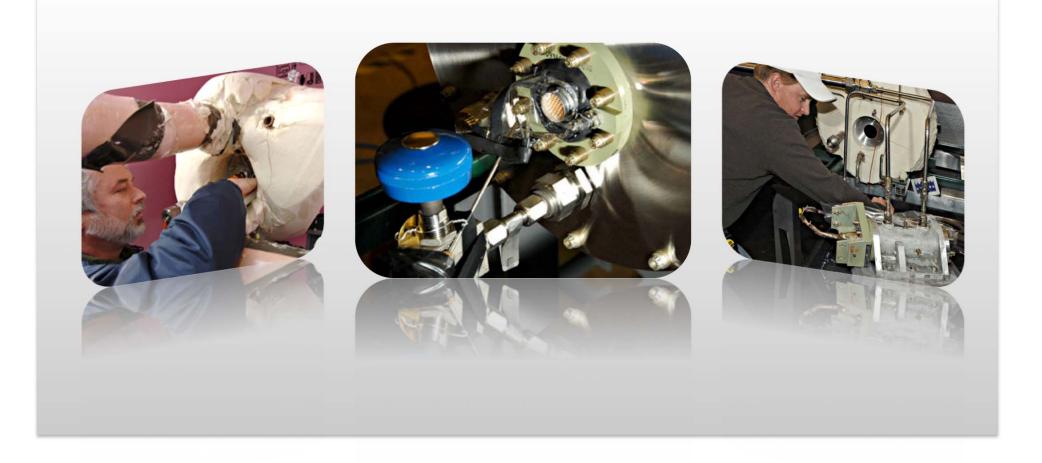




Regularly Scrubbing Requirements to Reflect Reality

Reducing Shuttle Risk: Low-level Main Engine Cutoff (ECO) Sensor

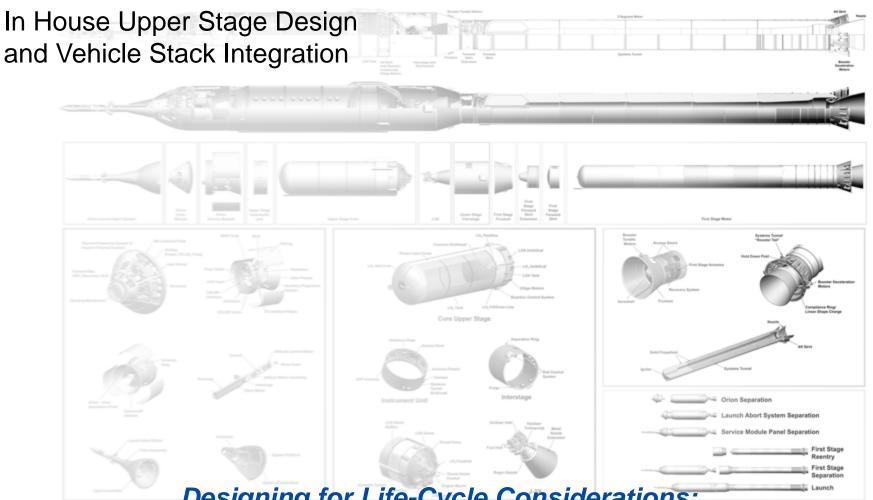




Solving Potentially Critical Anomalies

Reducing Technical Risk for Ares I Crew and Ares V Cargo Launch Vehicles

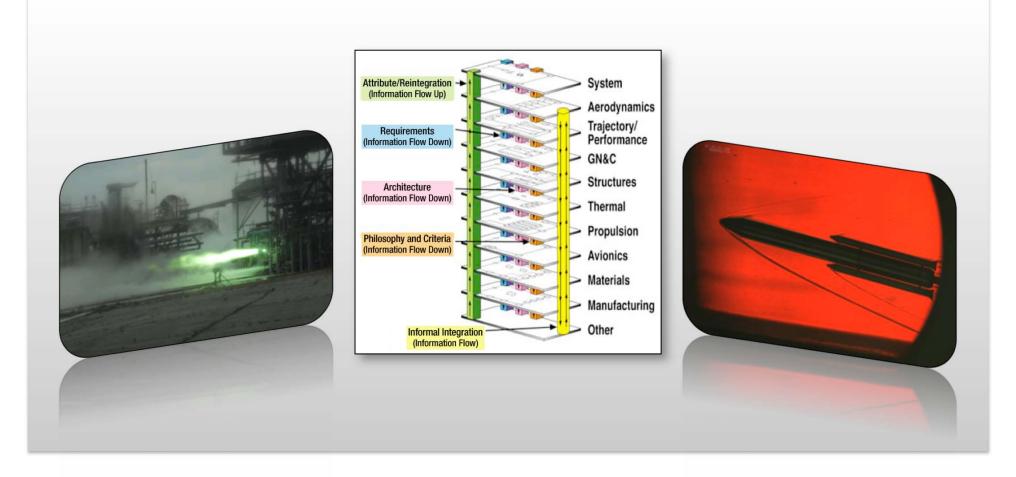




Designing for Life-Cycle Considerations: Safety, Reliability, Affordability

Systems Engineering Throughout the Project Lifecycle

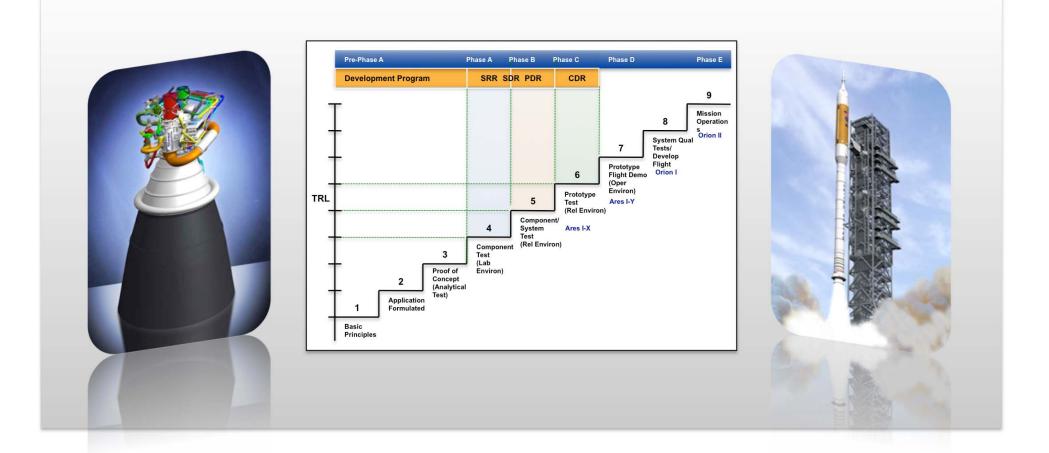




Testing Philosophy Drives Failures

Testing for Knowledge Versus Testing for Success

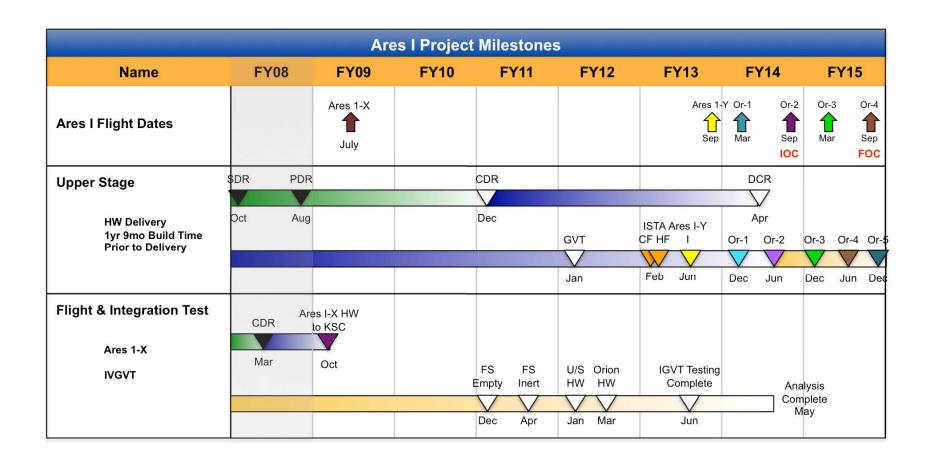




Technology Readiness Levels Drive Testing Objectives







System-Level Tests Inform Major Engineering Milestones & Validate Readiness

Ares I-X Development Flight Test: Breaking the Systems Engineering Model









Validates Modeling and Simulation, and Tests Operations Concepts

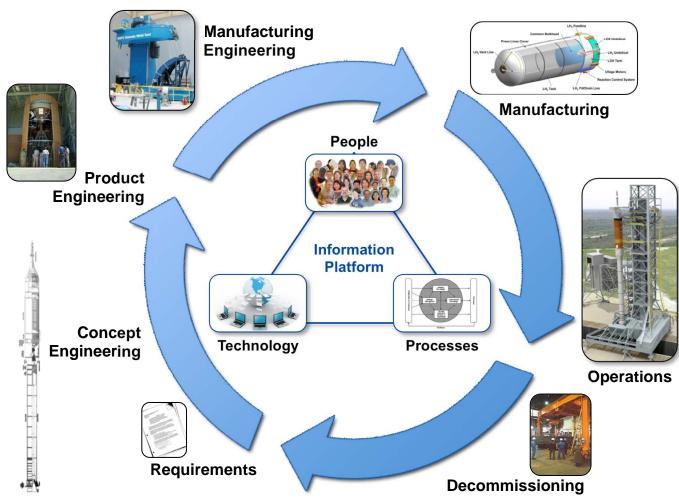
Generating & Analyzing Data to Reduce Risk: Main Propulsion Test & Integrated Vehicle Ground Vibration Test



Testing the Edges and Margins on the Ground Verifies Design Performance & Validates Computer Models

Project Lifecycle Management Model: Reducing Undefined, but Known, Risks

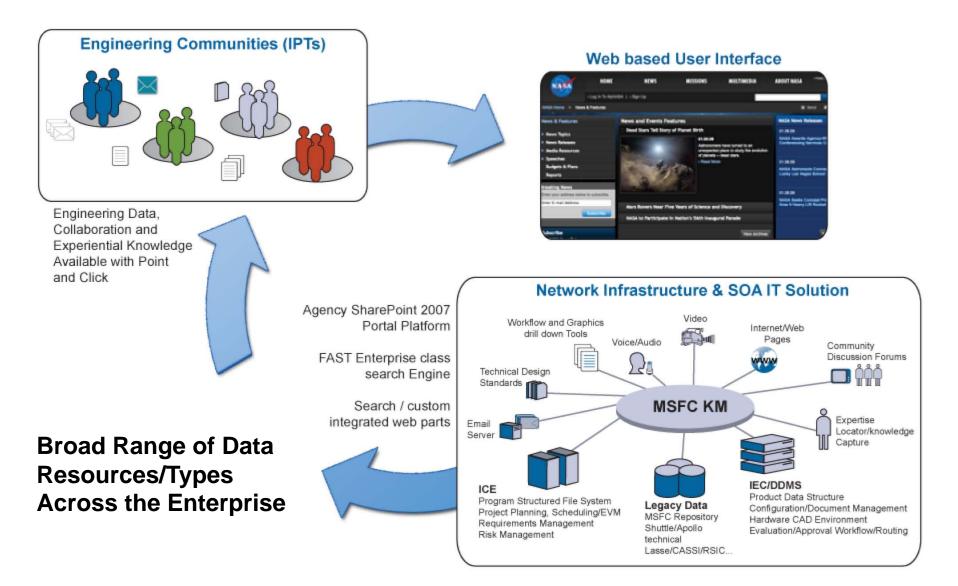




Designing with the End in Mind







Conclusion: Reducing the Risk Inherent in the Human Exploration of Space



Engineering is a great profession. There is the satisfaction of watching a figment of the imagination emerge through the aid of science to a plan on paper. Then it moves to realization in stone or metal or energy. Then it brings homes to men or women. Then it elevates the standard of living and adds to the comforts of life. This is the engineer's high privilege.

— Herbert Hoover

U.S. Mining Engineer & Politician (1874 – 1964)

One Good Failure Is Worth a Thousand Successes